

## MATERIAL PROCESSING APPARATUS

### BACKGROUND OF THE INVENTION

This invention relates to improvements in systems for automatically handling fluids, including reagents, mixture components, or other such fluids. The term "fluid" as used herein is intended to mean any substance that can be pumped, or conveyed through a tube, including slurries or fine powders which behave as fluids.

The most pertinent prior art presently known to applicant is his own U.S. Pat. No. 3,868,715.

### SUMMARY

According to this invention, a pump and an improved selector valve means are arranged to direct selectively the flow between the storage tanks of one or more substances and one or more processing containers where the substances may be utilized sequentially or intermixed, as required. The pump may be reversible to remove used substances from the processing container or containers, for return to respective storage tanks for subsequent re-use, or for delivery to a sump or the like for disposal as waste. Two selector valves may be provided, one for selecting a storage tank and one for selecting a processing container, which may also be a tank. This arrangement enables separate operations, such as multiple batch photographic developing, to take place concurrently or in overlapping time periods in different processing containers. Additionally, several valves may be interconnected to perform more complex operations.

For certain applications, one or more of the processing and/or storage tanks may be provided with means for excluding ambient light and air, and vent means for releasing gas from the tank. A processing tank may also include means for supplying dry and/or heated air to material such as photographic film in the tank.

The improved selector valve includes a base plate provided with a first aperture or port and a plurality of second ports disposed at points on a circle concentric with the first port, and a fluid conducting rotor arm extending radially from the first port and having a vertically articulable extension adapted, when lowered, to engage one of the second ports. A motor is arranged to rotate the rotor arm into alignment with the selected one of the second ports. Means are included for sensing such alignment, and for driving the extension downward into engagement with the second port. Further means are provided for sensing lack of such engagement, and preventing application of fluid in event engagement is not present.

For processes in which temperature is a factor, one or more of the storage tanks and/or processing containers may be immersed in a temperature-control bath, comprising a tank containing a working fluid, such as water, with heating and/or cooling means controlled by a temperature sensing device to maintain the bath at the desired temperature. The bath is provided with means for continually circulating the working fluid.

One or more of the processing containers may be provided with agitator means to maintain homogeneity of the fluid during processing. Fluid agitation is preferably accomplished by an ultrasonic generator. The transducer could be driven by a generator producing a signal having a complex waveform, in order to prevent formation of standing waves in the processing tank. Such standing waves are objectionable, for example, in pho-

tographic or x-ray processing processes, since they tend to produce streaks on the film.

The entire system, including selector valves, pump, air supply, temperature control, and agitator means is preferably controlled by a programmable digital device such as a microprocessor, which may be incorporated with a keyboard or other suitable input means as a part of the structure of the apparatus, or by a physically separate device such as a computer or mini-computer with suitable peripheral means for sensing conditions in the processing apparatus and starting and stopping the various functions.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a fluid processing system according to the invention;

FIG. 2 is a modification of the system of FIG. 1.

FIG. 3 is a top plan view of a selector valve used in the systems of FIGS. 1 and 2;

FIG. 4 is a side elevational view of the valve of FIG. 3;

FIG. 5 is a side elevational view in cross section, taken along line 5—5 of FIG. 3;

FIG. 6 is a top plan view of a tank, used in the embodiment of FIGS. 1 or 2;

FIG. 7 is a sectional view in elevation of the tank of FIG. 6 taken along line 7—7;

FIGS. 8, 9, and 10 are front, side and top views, respectively, of a processing tank for use in the systems of FIGS. 1 and 2;

FIG. 11 shows apparatus for blowing dried and/or heated air into the tank of FIGS. 8, 9, and 10;

FIG. 12 is a partial section of a poppet valve and actuator arrangement for use with the selector valve of FIGS. 3, 4, and 5; and

FIG. 13 is a schematic diagram of the electrical circuits and control apparatus for the systems of FIGS. 1 and 2.

### DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1, a processing container 101, illustrated in this case as a tank, is connected by a fluid conduit 102 to a reversible pump 103, which in turn is connected by a conduit 104 to a first or common port 105 of a selector valve 106. Pump 103 is arranged to be driven by a reversible electric motor 125, which is controlled by signals from the control unit by line 126. Valve 106 is provided with a plurality of second ports 107—111 and a fluid conducting arm 113, rotatable about the common port 105 to selectively connect the common port 105 to any one of the second ports 107—111. In the valve position of FIG. 1, ports 105 and 109 are in fluid communication. The structure of valve 106 will be described later in more detail. The pump 103 may be a flexible impeller pump or a rotary vane pump.

Ports 107—110 are connected by respective conduits to fluid storage tanks 114—117, each adapted to contain a supply of a fluid to be utilized in the processing container 101. Port 111 of valve 106 is connected to a sump or waste receptacle 112. This sump might also be a container to be filled with the mixture in the processing tank. When the apparatus is to be used in temperature sensitive operations, such as photographic processing, tanks 101 and 114—117 may be immersed in a temperature-control bath comprising a tank 118 containing a